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ments have been made to cool all the mirrors in the same way. The small electric fans to be used for this purpose will be operated while the adjustments of the spectroheliograph are being made, and also between exposures, when the mirrors are shielded from the Sun by an adjustable canvas screen.

Excellent definition is obtained at night with the Snow telescope, except when the mirrors have been exposed to the Sun for some hours during the afternoon. On such occasions the rapid change of figure during the early evening results in irregular distortions, as indicated by the multiple images sometimes observed. Without such previous exposure to the Sun, the images of the stars and of the Moon leave nothing to be desired. Nevertheless there is a considerable change of focal length during the night, but this would be inappreciable during short exposures, and during long exposures on stellar spectra it is only necessary to correct the focus by changing the position of the concave mirror from time to time.

From a mechanical standpoint the Snow telescope has proved to be completely successful. From an optical standpoint it has shown itself capable of giving results with the spectroheliograph superior to those obtained in our work with the 40-inch refractor. In view of the advantages it offers for many classes of astrophysical research, this telescope may now be considered to have passed the experimental stage, though the possibility of providing better material for the mirrors indicates that its optical performance will probably be considerably improved in the future.

GEORGE E. HALE.

SOLAR OBSERVATORY.

PHOTOGRAPHIC OBSERVATIONS OF THE SPECTRA OF SUN-SPOTS.[1]

(1) Our photographs of the spectra of sun-spots clearly record the strengthened and weakened lines, and can be advantageously used in place of visual observations.

(2) Table I gives the intensities on the photographs of the principal lines in the region λ 5000 – λ 5850.

(3) Table II shows that nearly three quarters of these lines are identified in ROWLAND'S table, and thus fails to support

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[1] Summary of results given in *Contributions from the Solar Observatory*, No. 5.

LOCKYER'S conclusion that at sun-spot maximum most of the known lines in spots are replaced by lines of unknown origin.

(4) All of the silicon lines in the region studied are much weakened, while other substances have only a small proportion of weakened lines.

(5) Table III gives the measured wave-lengths of the faint ("band") lines photographed in the region λ 5030 – λ 5215. Comparison with ROWLAND'S table shows that these lines, which are considerably strengthened in spots, correspond with the extremely faint lines of the solar spectrum.

(6) A review of the literature indicates that these lines are the ones seen visually by YOUNG, DUNÉR, and others who have resolved the general absorption in spots, and that they account for most, if not all, of the so-called "bands."

(7) Our results confirm YOUNG'S conclusions that the absorption in sun-spots is due to gaseous matter, and not to solid or liquid particles.

(8) After discussing the views of EVERSHED and WILSON on the cause of the darkness of sun-spots, we conclude that it may be sufficiently well accounted for by absorption alone.

GEORGE E. HALE AND WALTER S. ADAMS.

SOLAR OBSERVATORY.

COLOR OF THE SHADOWS OF *JUPITER'S* SATELLITES PROJECTED ON THE DISK OF THE PLANET.

On the evening of December 23, 1905, I was showing the visitors *Jupiter* through the large refractor. The seeing was good and the sky clear. The shadows of satellites I and III were on the disk of the planet. The shadow of I fell upon the dark-red equatorial belt of the planet near the meridian, just northwest of the great red spot; the shadow of III had just entered upon the disk very near the south pole of the planet.

It was at once seen that the two shadows were not equally dark. The shadow of III was a dense black, while that of I was not completely devoid of color. The character of the backgrounds was quite different, that upon which the shadow of I was projected being several shades darker than the white, cloudy region upon which the shadow of III fell. The effect of contrast would be, of course, to make the shadow which fell upon the brightest region (III) appear the darkest. The